

Claims

What is claimed is:

- 1 1. For use in a data processing system that includes a memory coupled to a
2 requester, the requester being capable of making a request to obtain data stored
3 within the memory, a coherency system, comprising:
4 a request channel to issue one or more types of requests from memory to the
5 requester; and
6 a response channel coupled to the request channel that is capable of
7 providing the data to the requester before read-only copies of the data stored within
8 the data processing system are invalidated.
- 1 2. The system of Claim 1, wherein at least one of the request and the response
2 channels include circuits to issue one or more invalidation requests to invalidate the
3 read-only copies of the data.
- 1 3. The system of Claim 1, wherein the response channel provides the data to
2 the requester, and further comprising an acknowledge tracker coupled to the request
3 channel to determine when all of the read-only copies of the data have been
4 invalidated, and to thereafter generate an acknowledgement to the requester.
- 1 4. The system of Claim 2, and further including a request tracking circuit coupled
2 to record that an acknowledgement is pending for the request.
- 1 5. The system of Claim 4, wherein the requester is capable of making multiple
2 requests for data, and wherein the request tracking circuit includes storage locations
3 to record, for each of the multiple requests, that an acknowledgement is pending.

6. The system of Claim 5, and further including:

an output buffer to store data that is to be transferred from the requester to the memory; and

control logic coupled to the output buffer to prevent the stored data from being transferred until acknowledgements have been received for each of predetermined ones of the multiple requests for which acknowledgements are pending at the time the data is stored to the output buffer.

1 7. The system of Claim 6, wherein the predetermined ones include all requests
2 from the requester.

1 8. The system of Claim 6, wherein the requester is a processing node having
2 multiple processors, and wherein the predetermined ones include requests that were
3 initiated by ones of the multiple processors that accessed the stored data within the
4 processing node.

1 9. The system of Claim 5, wherein the requester is a processing node having
2 multiple processors and a cache, and wherein the request tracking circuit includes
3 snapshot circuits to record if data is being stored to the cache by any of the multiple
4 processors that issued at least one request for which an acknowledgement is
5 pending.

1 10. The system of Claim 9, wherein the request tracking circuit includes circuits to
2 prevent the data stored to the cache from being flushed to the memory until
3 acknowledgements that are pending at the time the data is stored have been
4 received on all requests that were issued by the processor that storing the data.

1 11. The system of Claim 9, wherein the request tracking circuit includes circuits to
2 prevent the data stored to the cache from being flushed to the memory until all
3 acknowledgements that are pending at the time the data is stored have been
4 received on all requests that were issued by any of the multiple processors.

1 12. The system of Claim 9, wherein the multiple processors are coupled to
2 implement a snoop protocol, and wherein the snapshot circuits include logic to
3 record when data is being stored to the cache as result of a snoop response at a
4 time when an acknowledgement is pending for at least one request issued by any of
5 the multiple processors.

1 13. The system of Claim 12, wherein the request tracking circuit includes circuits
2 to prevent the data stored to the cache from being flushed to the memory until all
3 acknowledgements that are pending at the time the data is stored have been
4 received on all requests that were issued by any of the multiple processors.

1 14. A method for maintaining coherency in a data processing system having a
2 memory including a request channel and a response channel, the method
3 comprising:
4 a.) requesting data from the memory;
5 b.) issuing one or more invalidation requests via one of the request or the
6 response channel if one or more read-only copies of the data exist within the data
7 processing system; and
8 c.) providing the data via the response channel to a requester that initiated
9 the data request of step a.) before all of the invalidation requests have been
10 completed.

1 15. The method of Claim 14, and further including:
2 d.) recording when the one or more invalidation requests have been
3 completed; and
4 e.) issuing an acknowledgement to the requester indicating all invalidation
5 requests have been completed.

1 16. The method of Claim 15, and further including:
2 issuing multiple requests for data to the memory; and
3 repeating steps a.) through e.) for each of the requests.

- 1 17. The method of Claim 16, wherein multiple requesters are coupled to the
2 memory, and wherein the issuing of the multiple requests is performed by the
3 multiple requesters.
- 1 18. The method of Claim 16, and including tracking, for each of the multiple
2 requests, whether an acknowledgment for the request is outstanding.
- 1 19. The method of Claim 16, and further including:
2 scheduling data for transfer from the requester to the main memory;
3 delaying transfer of the scheduled data until acknowledgements that are
4 outstanding at the time the data is scheduled on predetermined ones of the requests
5 have been received.
- 1 20. The method of Claim 19, wherein the predetermined ones of the requests
2 include all requests from the requester.
- 1 21. The method of Claim 19, wherein the requester includes multiple processors,
2 and wherein the predetermined ones of the requests include requests from one or
3 more of the multiple processors that accessed the scheduled data.
- 1 22. The method of Claim 18, wherein the requester includes a cache, and further
2 including recording, when data is stored to the cache, that acknowledgements for
3 predetermined ones of the requests are outstanding.
- 1 23. The method of Claim 22, and further including preventing the data that was
2 stored to the cache from being transferred by the requester until all
3 acknowledgements for the predetermined ones of the requests have been received.
- 1 24. The method of Claim 23, wherein the predetermined ones of the requests
2 include all requests for which acknowledgements were outstanding at the time the
3 data was stored to cache

1 25. The method of Claim 23, wherein the requester includes multiple processors,
2 and wherein the predetermined ones of the requests include all requests that are
3 outstanding at the time the data is stored to cache, and that were issued by one or
4 more of the multiple processors that accessed the data that was stored to the cache
5 after the data was received from the memory.

1 26. The method of Claim 18, and further including receiving a return request from
2 the memory requesting return of data retained by the requester.

1 27. The method of Claim 26, and including preventing the retained data from
2 being returned to the memory until all outstanding acknowledgements for
3 predetermined ones of the requests have been received.

1 28. The method of Claim 27, wherein the predetermined ones of the requests
2 include all requests for which acknowledgements that are outstanding at the time the
3 return request is received.

1 29. The method of Claim 27, wherein the requester includes multiple processors,
2 and wherein the predetermined ones of the requests include all requests that are
3 outstanding at the time the return request is received, and that were issued by one
4 or more of the multiple processors that accessed the retained data after the retained
5 data was obtained from the memory.

1 30. For use in a data processing system, a system for maintaining memory
2 coherency, comprising:
3 request means for issuing requests; and
4 storage means for storing data, the storage means comprising:
5 request channel means for issuing one or more requests to the request
6 means; and
7 response channel means for providing data to the request means at
8 least one of the response channel means and the

9 request channel means including means for initiating invalidation of read-
10 only copies of the data existing within the data processing system, and the
11 response channel means including means for providing data to the
12 request means before all of the invalidation requests are completed.

1 31. The system of Claim 30, wherein the storage means further includes
2 acknowledge tracker means for initiating sending of an acknowledgement to the
3 request means when all invalidation requests have been completed.

1 32. The system of Claim 31, wherein the request means includes request tracker
2 means for recording when an acknowledgement is outstanding for a request.

1 33. The system of Claim 32, wherein the request tracker means includes control
2 means for preventing data from being transferred from the requester to the storage
3 means when an acknowledgement is pending for any requests that are associated
4 with the data.

1 34. The system of Claim 33, wherein the associated requests include all requests
2 pending at the time it is determined that the data should be transferred from the
3 requester.

1 35. The system of Claim 34, wherein the request means includes multiple
2 processors, and wherein the associated requests include all requests pending at the
3 time it is determined that the data should be transferred from the requester and that
4 are requests issued by any of the multiple processors having access to the data
5 while the data was retained by the requester.

1 36. The system of Claim 32, wherein request means includes cache means, and
2 wherein the request tracker means includes means for recording, at the time data is
3 stored within the cache means, whether any outstanding acknowledgments exist for
4 requests associated with the data.

1 37. The system of Claim 36, wherein the requests associated with the data
2 include all requests issued by the requester for which acknowledgements are
3 outstanding.

1 38. The system of Claim 36, wherein the request means includes multiple
2 processors, and wherein the requests associated with the data include requests
3 issued by ones of the multiple processors that accessed the data while the data was
4 retained by the requester.

1 39. The system of Claim 32, wherein the storage means issues return requests to
2 the requester for return of data signals, and wherein the request tracker means
3 includes means for preventing return of the requested data signals until all
4 acknowledgments that are outstanding at that time are received.

1 40. The system of Claim 32, wherein the storage means issues return requests to
2 the requester for return of data signals, and wherein the request tracker means
3 includes means for preventing return of the requested data signals until all
4 acknowledgments that are outstanding at that time are received on requests initiated
5 by processors that accessed the requested data signals.